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(54) IMPACT DAMPING MEANS FOR FLUID ACTUATORS

(71) We, MOSIER INDUSTRIES INC., a Corporation organized and existing under the laws of the State of Ohio, United States of America, of 2220 W. Dorothy Lane, Dayton, Ohio 45439, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

THIS INVENTION relates to impact damping means for fluid operated piston and cylinder assemblies.

There have been various proposals to damp or cushion the impact of pistons upon the heads of power cylinders, at the end of the piston stroke. In differing forms, resilient bumpers have been applied to the piston itself, or to the head of the cylinder containing the piston. The present invention relates to improvements in or modifications of the invention of our copending Patent Application No. 8509/73 (Serial No. 1,401,126) which, *inter alia*, claims impact damping means for fluid actuators comprising a circular ring of resilient rubber-like material having a central opening, an annular planar mounting flange, an annular sealing lip, and a resilient annular bumper intermediate the flange and the sealing lip.

According to the present invention there is provided an impact damping means for fluid actuators comprising a circular ring of resilient rubber-like material having a central opening, an annular planar mounting flange, an annular sealing lip, and a resilient annular bumper intermediate the flange and the sealing lip projecting in the same direction as and axially beyond the sealing lip, the outer surface of the sealing lip being inclined at an angle of substantially 15° from the axis of the ring.

A second aspect of the invention provides impact damping means for fluid actuators comprising a circular ring of resilient rubber-like material having an outer peripheral circumferential edge and an inner peripheral edge defining a central opening through the ring, an annular planar mounting flange adjacent said inner peripheral edge, an annular, continuous, axially projecting combination sealing lip and bumper adjacent the other peripheral edge, the sealing lip and bumper including a pair of radially outwardly inclined inner and outer surfaces, the combination lip and bumper terminating in a leading edge which extends radially inwardly and forwardly from the circumferential edge of the outer surface of the sealing lip to a rounded surface which is tangent thereto and to the inner inclined surface of the combination sealing lip and bumper.

Yet another aspect of the invention provides a fluid actuator with damping means comprising a fluid cylinder having opposite cylinder heads each including an inner face, a piston reciprocable within the cylinder toward and from said faces, means for admitting fluid for reciprocating the piston, and impact damping means according to the first or second aspect of the invention, annular flanges on the piston being arranged in spaced parallelism to provide a groove supporting the mounting flange of the impact damping means whereby the bumpers of the damping means are engageable with the respective faces upon movement of the piston to opposite ends of its stroke.

The invention will be further described, by way of example, with reference to the accompanying drawings, in which:

FIGURE 1 is a vertical longitudinal cross sectional view of a fluid actuator embodying the impact damping means according to the invention applied to a piston in a fluid cylinder, the piston being

shown in an intermediate position between the cylinder heads;

FIGURE 2 is a fragmentary cross section on an enlarged scale showing an impact damping ring as used in the actuator of Figure 1;

FIGURE 3 is a fragmentary cross section on an enlarged scale showing another modification of the damping ring;

FIGURE 4 is a view illustrating the ring of Figure 3 but with a modification; and

FIGURE 5 is a fragmentary cross section on an enlarged scale showing a further embodiment of damping ring.

Figure 1 illustrates an actuator comprising a fluid cylinder 12 having heads or end elements or walls 14, 16, a reciprocatable piston rod 20, a piston 18 fixed upon the rod 20, ports 22 and 24 through which fluid can be fed to actuate the piston and rod, and a packing gland 26 through which the piston rod 20 reciprocates. The operating fluid may be liquid or gaseous in form, and will be fed under pressure to either port 22 or 24, depending upon the direction of movement to be imparted to the piston and rod. As will be understood, in accordance with common practice, one of the head ports will exhaust fluid from one end of the cylinder while the other port directs pressurised fluid into the opposite end thereof.

With reference to Figures 1 and 2 the reference numeral 28 indicates impact damping means in the form of bumper sealing rings applied to the piston at opposite ends thereof. The two rings are identical one with the other. As shown the ring 28 has a large central opening 30 circular in shape and is defined by an inwardly directed annular mounting flange 32 which fits snugly within an annular piston groove 34 formed in the material of the piston. The piston groove 34 at the right hand end of the piston is shown as being defined by spaced parallel annular flanges, the outer one of which is shown at 36 and the inner one of which forms part of he cylinder body. The ring 28 is formed or moulded of resilient rubber-like material and it may, therefore, be stretched and distorted as required to seat or to unseat it with respect to the piston groove 34. Adjacent to the mounting flange 32, the thickness of he ring 28 is increased to provide an annular resilient bumper 40 which extends a substantial distance beyond the flange 32 in the direction of the ring axis. The crest or leading edge of the bumper is adapted yieldingly to contact an inner face 42 of the cylinder head for the purpose of damping or absorbing shock caused by a forceful impact of the piston against the inner face of the head. The bumper has an interior annular wall 44 (Figure 2) which is inclined relative to the external annular wall 46, resulting in a reduction of material at the crest of the bumper. This produces a progressively increasing resistance to impact in the body of the bumper, from the crest thereof to the bumper face, which latter includes the mounting flange 32. The face of the bumper is coplanar with the annular flange 32 disposed approximately normal to the external wall 46. Integral with the bumper, and flared outwardly from the wall 46, is an annular external sealing lip 48. The lip 48 is flexible and resilient and may therefore be crowded against the inner wall of the cylinder 12 during reciprocation of the piston to provide a fluid seal. The sealing lip 48 and bumper 40 have a base 49 and the leading edge 51 of the lip 48 extends in the general direction of the bumper. It will be noted, however, that the crest of the bumper projects axially well beyond the leading edge 51 of the sealing lip. Moreover, the sealing lip projects no further than the outer face of piston flange 36.

The forceful advancement of the piston 18 left will cause the annular bumper 40 to flatten evenly against the inner face 42 of the cylinder head 14, thereby cushioning impact. If the volume of that portion of the bumper which extends beyond the face of the piston is equal to or less than the available void volume within the face of the piston the bumper can absorb impact and still permit the piston to home solidly against the inner face of the cylinder head. The sealing lip 51 will preferably not bear against the head in the fully advanced condition of the piston.

Bleed holes 52 are provided between the inner face of the head and its fluid port, serving to relieve fluid that may be trapped during cushioning of the piston advancement. The bleed holes, if desired, may be fitted with needle valves or equivalent control means for the purpose of flow variation and consequent adjustment of the cushioning effect.

Referring to Figure 1 the central annular flange of the piston is provided with an inclined or chamfered annular shoulder 54 of limited width which, in the absence of fluid pressure acting against the sealing lip, is spaced from the base portion 49 thereof. However when pressure fluid is imposed on the leading edge 50 of the sealing lip the pressure will expand the lip against the cylinder wall and at the same time flex the base portion 49 against the inclined shoulder 54. Such flexing of the base portion 49 occurring repeatedly as the piston movement changes direction serves to prevent the leading edge of the sealing lip from taking a set radially inwardly toward the bumper, such as would eventually induce leakage of

fluid past the sealing lip.

The damping means of Figure 2 is shown with an outer surface 61 of the annular external sealing lip 48 which is inclined, or tapered, in a substantially straight line from the forward tip 51 to rounded shoulder 63 which is tangent to the surfaces 61 and 49. Satisfactory results have been obtained with the ring of Figure 2 when the surface 61 of the sealing lip is inclined substantially 15°, and the surface 71 is inclined substantially 20 with reference to surface 30 of the combinaion impact and sealing ring member, the surface 46 of the bumper 40 being substantially parallel with the surface 30 and surface 44 being inclined substantially 20° with reference to surface 30.

By thus providing an elongate, outer, straight, tapered surface 61 to the annular external sealing lip 48, a good overall efficiency and useful life is given to the combination impact and sealing ring member, since temperature rises, in the sealing ring member, as the result of friction between contacting surfaces of the sealing lip and the inside diameter of the cylinder 12 is kept low, particularly where the ring member is utilised in applications in which rapid or high speed cycling of the piston occurs. The seal illustrated in Figure 2 is particularly adapted for use in cylinders having a bore diameter of 5 inches or greater.

Figure 3 discloses a modification of the combination impact sealing ring member of Figure 2 for use in cylinders having bores of a diameter ranging from about 1.5 to 4 inches. The outer surface 81 of the sealing lip is tapered in the same manner as surface 61 of Figure 2, however surface 83 is inclined substantially 15° with reference to surface 30, the overall shape of the bumper 40 of Figure 3 differing from the shape of the bumper of Figure 2 in that the bumper of Figure 3 is defined by inclined surfaces 71 and 73 each of which are inclined about 10° with reference to surface 30.

Figure 4 is a sectional view of a seal similar to that of Figure 3 wherein a relief port 56 has been disposed transversely across the crest or leading edge of the bumper 40.

Figure 5 discloses a modification of a combination impact and sealing ring member which has been particularly designed for use with cylinders having bores with a diameter of about 1 1/8 inches and less wherein the sealing lip and bumper collectively comprise a single, axially projecting member having common surfaces 91 and 95. Satisfactory results have been obtained in those instances in which surface 91, which tapers to a substantially straight line from tip 90 to rounded corner 63 which is tangent to the surface 91 and 49, is inclined at an angle of approximately 12° with respect to reference surface 30. Forward edge 93 tapers downwardly and outwardly in a substantially straight line from tip 90 to rounded corner 94 which is tangent to surfaces 93 and 95 wherein surface 95 is inclined about 25° with reference to surface 30. In those instances in which the combination impact and sealing ring member of Figure 5 is used, it should be understood that the rounded portion of nose 94 comprises the forward portion of the bumper and that said rounded surface will initially engage the face of the end wall of the cylinder head by initially absorbing the cylinder impact and, as the sealing member is progressively compressed and distorted as the face of the piston approaches and contacts the inner face of the end wall of the cylinder, outer surface 91 will expand and snugly engage the inner surface of the wall of the cylinder for an appreciable distance rearwardly of the forward portion 94.

From the foregoing it will be noted that in all the embodiments described the combination impact damping and sealing ring means constitutes a one-piece resilient ring having a plurality of continuous annular surfaces, certain of which define a resilient sealing lip, others of which define a single, annular, continuous resilient bumper, others of which define a central opening 30 and an annular mounting flange 32.

While generally the rings of Figures 2, 3, 4 and 5 are shown with a sealing surface radially outwardly they may be rearranged so as to have a radially inwardly sealing surface and a radially outwardly directed mounting flange so as to be mountable in the cylinder heads with the sealing surface being engageable with the piston rod and the bumper being engageable with the piston.

WHAT WE CLAIM IS:—

1. An impact damping means for fluid actuators comprising a circular ring of resilient rubber-like material having a central opening, an annular planar mounting flange, an annular sealing lip, and a resilient annular bumper intermediate the flange and the sealing lip projecting in the same direction as and axially beyond the sealing lip, the outer surface of the sealing lip being inclined at an angle of substantially 15° from the axis of the ring.

2. Impact damping means as claimed in claim 1, wherein the juncture between the inclined surface and a surface of the planar mounting flange is defined by a rounded edge which is tangent to each of said surfaces.

3. Impact damping means as claimed in claim 1 or 2, wherein the inner surface

of the sealing lip is inclined at an angle of substantially 20° from the axis of the ring.

4. Impact damping means as claimed in claim 1, 2 or 3, wherein the bumper is defined by a first substantially axial surface adjacent the inner inclined surface of the sealing lip substantially parallel with the axis of the ring and a second surface which is inclined downwardly and away from the leading edge of the bumper at an angle of substantially 20° relative to the axis of the ring.

5. Impact damping means as claimed in claim 1, 2 or 3, wherein the bumper is defined by a pair of substantially straight surfaces which diverge from the leading edge of the bumper, said surfaces each being inclined at substantially 10° relative to the axis of the ring.

6. Impact damping means according to any preceding claim, wherein the sealing lip terminates in a leading edge disposed in a plane which is substantially normal to the axis of the ring.

7. Impact damping means for fluid actuators comprising a circular ring of resilient rubber-like material having an outer peripheral circumferential edge and an inner peripheral edge defining a central opening through the ring, an annular planar mounting flange adjacent said inner peripheral edge, an annular, continuous, axially projecting combination sealing lip and bumper adjacent the other peripheral edge, the sealing lip and bumper including a pair of radially outwardly inclined inner and outer surfaces, the combination lip and bumper terminating in a leading edge which extends radially inwardly and forwardly from the circumferential edge of the outer surface of the sealing lip to a rounded surface which is tangent thereto and to the inner inclined surface of the combination sealing lip and bumper.

8. Impact damping means according to claim 7, wherein the outer surface of the sealing lip is inclined at an angle of substantially 12° and wherein the inner surface of the bumper is inclined at an angle of substantially 15° with reference to the axis of the ring, the leading edge being inclined at an angle of substantially 20° relative to a plane normal to the axis of the ring.

9. Impact damping means for fluid actuators constructed and arranged substantially as hereinbefore described with reference to and as illustrated in Figure 2, Figure 3, Figure 4 or Figure 5 of the accompanying drawings.

10. A fluid actuator with damping means comprising a fluid cylinder having opposite cylinder heads each including an inner face, a piston reciprocable within the cylinder toward and from said faces, means for admitting fluid for reciprocating the piston, and impact damping means according to any preceding claim, annular flanges on the piston being arranged in spaced parallelism to provide a groove supporting the mounting flange of the impact damping means whereby the bumpers of the damping means are engageable with the respective faces upon movement of the piston to opposite ends of its stroke.

11. A fluid actuator according to claim 10, wherein means are provided operative on entrapment of cylinder fluid between the annular bumper and the inner faces of the cylinder heads for relieving pressure entrapped fluid as the piston approaches contact with said inner faces.

12. An actuator as claimed in claim 11, wherein the pressure relieving means includes a bleed opening in the cylinder head.

13. An actuator as claimed in claim 12, wherein the pressure relieving means includes one or more transverse ports in the annular bumper.

14. Fluid actuator constructed and arranged to operate with fluid damping means substantially as hereinbefore described with reference to and as illustrated in any one of Figures 2 to 5 of the accompanying drawings.

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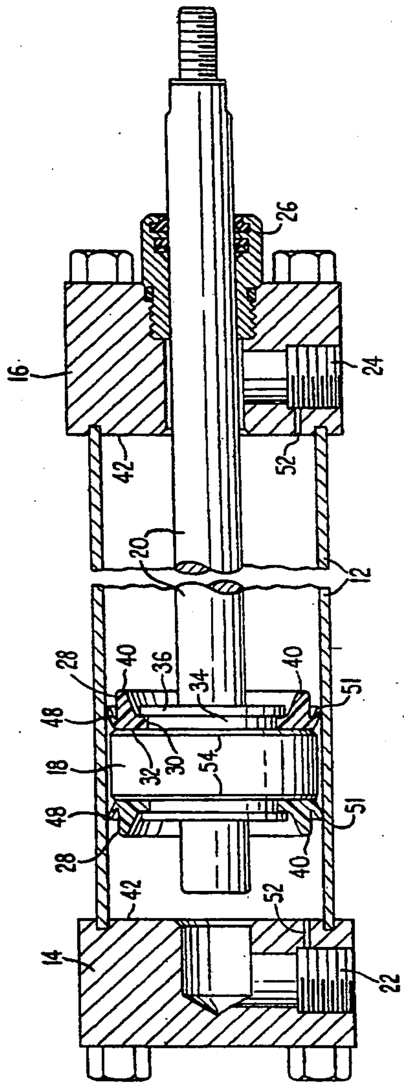

FIG. 1

FIG.2

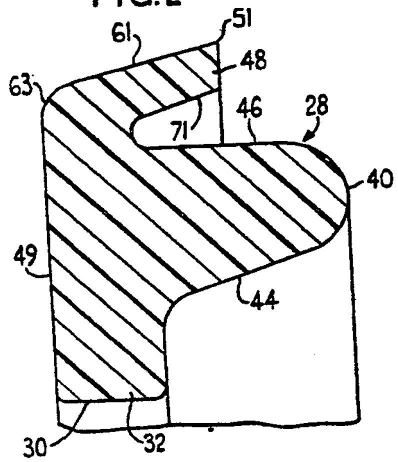

FIG.3

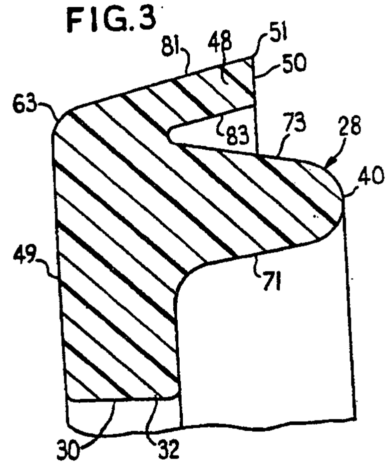

FIG.4

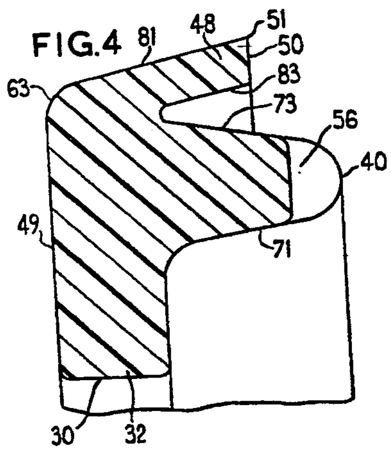

FIG.5